NEW AMERICA
FOUNDATION

March 17, 2004

Issue Memo:

Unlicensed Wireless Last-Mile Case Studies
Community and Entrepreneurial Success Stories in the Last-Mile

Think Globally, Act Locally
WISPs Come of Age: From Localized Hotspots to Organic Hot Pathways

At the onset of the unlicensed movement, Wireless Internet Service Providers (WISPs) were typically small-scale efforts to bring broadband access to local areas using adapted WiFi equipment. Many of these efforts were scaled-up versions of the WiFi hotspots, now ubiquitous in urban coffee shops, hotel lobbies, and even some public parks. In recent years, however, unlicensed equipment has advanced well beyond WiFi to include more sophisticated technologies -- such as frequency-hopping, non-line-of-sight transmitters, mesh networks, and high-gain directional antennas that can make point-to-point connections over 20 miles. These days, providers construct networks into scalable cell sectors with varying levels of redundancy and security based on customer need, and they carefully engineer their deployments to accept more subscribers without compromising service as the network expands. In fact, the most successful WISPs have long-since outgrown the hotspot model and are now building contiguous wide-area networks that have raised the standard for unlicensed service.

One company that is redefining the notion of a WISP is AMA*TechTel Communications of Amarillo, Texas. With more than 4,000 users on their license-exempt network, AMA*TechTel is one of the country's largest regional carriers of wireless broadband.

The company has built a 20,000 square mile, organic network comprised of 63 transmitting towers stretching across the North Texas plains.

According to Patrick Leary, the "Chief Evangelist" for Alvarion, one of the largest manufacturers of broadband wireless technology, the AMA deployment is a sophisticated, contiguous network that provides secure service to residential, corporate and educational campuses. Using Alvarion transmitters and multiple unlicensed bands (to include 900 MHz, 2.4 GHz, and 5 GHz) AMA has created private virtual environments for three college campuses, multiple school systems, law enforcement and public safety agencies, hospitals, and numerous banks within their expanding footprint.

The company is now building a wireless backbone for Texas Tech University that will connect Amarillo to Hobbs, New Mexico and provide broadband access to communities along its route. This wide area network will support K-12 and adult education and business development programs.

The expansiveness of the AMA network is due to the company's partnership with Attebury Grain, a large grain storage company that contracted AMA to connect their grain elevators to the commodities market. After the project, the two companies combined forces to widen the network using Attebury's numerous grain elevators to reach towns and businesses within line-of-sight of the elevator towers.

The wireless service is becomingly increasingly popular with residents in North Texas towns who may or may not have DSL access. According to AMA*TechTel Vice President of Business Development, Douglas Campbell, the company has been growing by 150 new subscribers a month with very little marketing.

The success of AMA*TechTel may be daunting to entrepreneurs wanting to enter the WISP arena, however this ambitious network may not be the only successful model available. Numerous smaller-scale providers have relied on skillful engineering and integrated technology packages to build smaller networks for remote communities (see previous sidebars). These localized efforts usually focus on rural communities that have no other option for broadband, where WISPs can safely access unlicensed spectrum without fear of harmful interference. One company that has implemented this localized approach on a large scale is Prairie iNet, of Des Moines, Iowa.

With a total network reach of approximately 20,000 miles, Prairie iNet builds localized wireless oases in communities long ignored by telecommunications and cable companies. By focusing on towns such as Broadland, Illinois (population 350) and 120 other communities in Illinois and Iowa, Prairie iNet has the flexibility to concentrate their efforts on specific markets with a broadband demand.

Like AMA*TechTel, Prairie iNet relies on the existing infrastructure of the high plains, with local silos, barns, and rooftops serving as towers for the company's point-to-point and point-to-multipoint transmitters. The company uses the 5 GHz frequencies for tower-to-tower and backhaul transmissions, while the last-mile connections to users are typically over a mile, and on the 2.4 GHz unlicensed band. The wireless networks

eventually connect to the Internet via a DS3 fiber line. As of the summer of 2003, more than 4,000 users were receiving high-speed connections on Prairie iNet networks.

Both the wide-area "hot pathway" model and the localized network design present varying benefits. Regional utility companies with existing towers and customer base can learn quite a bit from AMA*TechTel and leverage their infrastructure and clientele to create scalable, secure virtual private networks (VPN) for larger organizations and residential service for customers. Utility companies around the country are rapidly following suit: East Bay Municipal Utility District in Oakland, California has recently installed the Motorola Canopy system; Owensboro Municipal Utilities in Kentucky and Wheatland Electric Cooperative, Inc. in Kansas have both installed Alvarion networks; and rural cellular providers like Midwest Wireless have also built a broadband business using unlicensed spectrum.

Localized networks, like the ones used by Prairie iNet offer a level of deployment flexibility not usually available with an existing fixed tower infrastructure. Localized networks can concentrate their infrastructure into the best available opportunity space and reach new markets quickly. This model has inspired small local providers to pop-up in many rural and suburban communities across the country. While hard data is unavailable about the number of localized providers in operation, In-Stat/MDR, a research and consulting firm, estimates in a 2002 report that there are up to 1,500 start-up WISPs in operation. Low start-up costs, numerous equipment options, and high consumer demand are part of this growth.

NYCwireless: Evolution of a Wireless User Group

To followers of the wireless broadband revolution, New York has been a hotspot of activity among U.S. cities, and the NYCwireless user group has been leading the movement. The group began as an informal network of early WiFi adopters who placed access points on their apartment widows to share their broadband access with the public parks below their buildings. As the trend gained acceptance, the users organized to form NYCwireless, a non-profit, volunteer organization, to encourage others to share their broadband and foster an ethic of free public Internet access across the city.

"New Yorkers live in cramped quarters, and our goal has been to get people out of their apartments and into the public parks," says NYCwireless volunteer Dustin Goodwin. The group considers ubiquitous broadband access to be a public amenity equivalent to streetlights or water fountains. However, it's difficult, if not impossible, to provide public parks with wired broadband access because of construction impediments on historic or public land. Cheap, and easily installed WiFi technology allowed apartment dwellers with good line-of-site to their parks to install the 802.11b transmitters and address the problem for themselves.

Volunteers from NYCwireless have built networks in Bryant Park, Bowling Green Park, and Tompkins Square Park, among others. This past year, founding members of the group formed a consulting firm, Emenity, to deploy six more public hot spots in lower Manhattan for the NYC Downtown Alliance. The new company was started to provide

service to commercial clients, but their mission of building public access networks remains intact.

Emenity has recently built a public network in Union Square Park. This project is unique in that it relies on a wireless backhaul to connect to the Internet provided by the commercial wireless broadband provider TowerStream. Most public access points in the city ultimately access the Internet via a DSL Internet connection.

The efforts of NYCwireless have not gone unnoticed by broadband service providers. Some providers have slapped "acceptable use" clauses on their subscriber contracts in an effort to discourage wireless bandwidth sharing. One large cable operator has been accused of sending out a WiFi "sniffer" to scour the city in search of access points leading back to their customers' connections to close down the transmitters.

However, as WiFi use has reached a critical mass, more broadband providers are trying to enter the public space arena. Speakeasy, Inc., a national DSL reseller, now offers "WiFi Netshare," a service that allows users to resell their broadband connections to neighbors, with Speakeasy handling the billing. And Verizon DSL has built a number of hotspots in New York that are free to their DSL home subscribers.

NYCwireless volunteer Dustin Goodwin sees the commercial attention to public WiFi in the city as a direct response to NYCwireless' success. While some see the entrance of commercial players into the public space as a threat to free access, others see the development as an important step to recognizing WiFi as a free public amenity that companies and organizations should provide as a value-added service to their constituents.

Now that wireless broadband has gained a foothold in New York City parks, Goodwin says that NYCwireless is expanding its mission to resemble a volunteer "Geek Corps" for communities without affordable broadband Internet. Currently, NYCwireless volunteers are helping a non-profit housing organization, Community Access, bring broadband to clients living in their community homes. The group has trained the housing residents to build and maintain a wireless network, which will provide more than 50 residents with private, high-speed connections.

This effort is part of a growing trend among wireless community groups across the country (see "Connected Communities" side-bar) to bring affordable broadband to underserved communities.

An Unlicensed Education
A Wireless Model to Connect Rural School Communities

While U.S. school districts have been issued the command to "leave no child behind," many rural schools are without the resources to bring broadband Internet access into their classrooms. This is especially true for rural communities beyond the reach of DSL or cable lines. This last-mile problem presents hardships not only for schools, but also for local households and businesses unable to fully participate in the information economy.

A public/private partnership has been formed in western Pennsylvania to use unlicensed spectrum and the social capital of local school districts to address the last mile on their own. Thus far, the efforts of the Broadband Rural Access Information Network (BRAIN) have yielded great results connecting rural areas, and their example could provide a template for other rural school communities across the country.

The BRAIN effort began with the vision of a small school district superintendent, Andy Demidont, and the help of a large regional WISP, Sting Communications. Demidont wanted to provide high-speed access to the Rockwood High School and the Kingwood Elementary School in mountainous Somerset County. The schools' existing dial-up accounts were expensive, and rendered connection speeds barely surpassing 14 kbps.

Relying on the technical guidance from Sting Communications, and using grant money awarded from the Individuals with Disabilities Act and E-Rate discounts, the school district installed wireless access points on the roofs of both schools, turning each school into state-of-the-art wireless hotspots.

In total, Sting Communications installed three towers, creating a pie-shaped hot-zone using the 5.8 GHz and 2.4 GHz license-exempt bands. The Rockwood High School gymnasium hosts a 100-foot tower that transmits to a 150-foot tower located at Kingwood Elementary school. The two towers share a narrow beam, point-to-point connection with a third tower owned by the local Seven Springs Ski Resort.

Simply bringing the technology to the area wasn't the end goal – using the network to connect the school with the community is the ultimate design of the project. Both the Rockwood and Kingwood schools have put many classroom and administrative operations on-line. Teachers use Palm Pilots and laptops to track student progress, design lessons, and record grades – which are available to parents online. Students can use the high-speed connection in each classroom, with each school "unwired" for access.

The project was designed to also give community residents a chance to purchase access from the school's network, with the school district serving as a WISP for the area. Between the three towers, Sting has installed access points in neighborhoods to provide coverage for much of the community. Sting has also provided an incentive for community members to join the network, by offering subscription rates between $11 and $20 per month, depending on the number of subscribers the school can attract. Currently, thirty-five families have been connected, with an additional 65 families expected to be online in the coming months.

From the project's onset, Sting hoped their approach could be replicated in other rural school communities. Building on what they have learned in Somerset County, Sting has built a much larger network in Cambria and Clearfield Counties to connect four more regional school districts. Sting Vice President Bob Roland says that this new network spans an 1100 square mile area, reaching residents of the Glendale, Philipsburgh, Osceola, and Moshannon Valley school districts. This network (see Figure 13 below) uses both 5 GHz frequency-hopping spread spectrum and 802.11 connections for the last mile.

BRAIN is seeking to expand the model into more communities. The group has applied for a $7.4 million grant from the USDA's Rural Utilities Service to "light-up" a wide corridor between central Pennsylvania and Maryland. This larger effort could provide a valuable last-mile case study for rural school communities around the country.

Revolution in the Rural Last Mile
Unlicensed Spectrum Closing the Technology Divide in Northern Virginia

Despite their proximity to northern Virginia's Internet backbone, many towns in Loudoun County have no broadband access. The mountainous western regions of the county are far from the technology infrastructure of Northern Virginia where companies like AOL and VeriSign reside. However, because of license-exempt wireless activity, the technology divide across the county is starting to close.

The Northern Virginia area profited from the technology boom of the late 90s. But, when the technology bubble burst, as many as 30,000 jobs in the region were lost. Many laid-off professionals accustomed to broadband connections at their work started their own businesses or began working from their homes, creating a large demand for high-speed home services. One local company, Roadstar Internet, is meeting that demand by building a rapidly growing wireless network in rural Loudoun County.

Started in the autumn of 2002, the Roadstar Internet network connects more than 150 rural households and small businesses using 100% unlicensed spectrum. Most wireless subscribers do not know exactly how their service operates; since what matters most to users is that their connections are fast and reliable, and not necessarily the technology behind the service. But, the Roadstar unlicensed network is similar in design to many other WISP efforts, and uses a combination of point-to-point connections for the long-distance transmissions, and point-to-multipoint transmissions to connect neighborhood access points to subscribers.

The first leg of the network travels 18 miles from a mountaintop transceiver using 5 GHz license-exempt bands. Roadstar uses OFDM (Orthogonal Frequency Division Multiplexing) technology that allows for point-to-point connections without perfect line-of-sight. OFDM transmissions make efficient, and secure, use of spread spectrum by dividing data into packets and encoding it over multiple frequencies.

Long distance point-to-point transmissions are the standard for rural WISPs seeking to extend their markets and reach larger population pockets. Under Part 15 rules for unlicensed usage, the FCC allows operators to make point-to-point connections without reducing Transmitter Power Output (TPO) for the 5.725 GHz and 5.825 GHz band. Because of this regulatory latitude for narrow beam transmissions, providers are able to reach long line-of-site distances with relatively low power.

The Roadstar network makes final, last-mile connections within neighborhoods by using modified WiFi wireless access points mounted on customer silos, barns and rooftops. Roadstar and other WISPs are able to transmit distances greater than the 300-foot standards for WiFi, 802.11b technology by creating sectorized cells with high-gain,

directional antennas. These last-mile connections on the 2.4 GHz band are the result of good planning and engineering, and typically reach two to three miles.

A Community Access Model for the Urban Last Mile
Community Access Networks as Last-Mile Innovation Incubators

While the success of commercial WISPs has generated much attention, grassroots community access networks or CANs are the originators of the unlicensed movement. Most CANs are groups of like-minded individuals sharing a similar philosophy—that citizens should and can have open, inexpensive, and ubiquitous access to the Internet. Using affordable and easily installed WiFi technology, community members in Seattle, New York, Austin, San Francisco, Portland, Oregon, and Athens, Georgia have built expanding networks of independently maintained wireless access points that are shared among many.

Most CANs provide access to people in public spaces, however some groups have made forays into residential space, by connecting neighborhoods with centrally placed access points. One such organization is the Bay Area Wireless Users Group (BAWUG), an informal group of wireless early adopters who began mounting WiFi transmitters on the roofs of their homes to give neighbors free or shared-cost Internet connections via their DSL and cable lines. While the cable and phone companies didn't approve of the practice, consumers did and access points began popping up all over the city. There are now over 25 BAWUG assisted access points in the area.

But BAWUG has not stopped there. Under the leadership of Tim Pozar, a telecommunications engineer and one of BAWUG's founders, the group has launched the Bay Area Research Wireless Network (BARWN). BARWN is an active wireless network with a mission to discover the best technical solutions to bring wireless broadband to remote and economically disadvantaged communities.

BARWN has set up two centrally located access points atop the San Bruno Mountain and Potrero Hill in south San Francisco, allowing anyone within an 8-mile radius to point a 2.4 GHz antenna at the BARWN towers to share the 11Mbps of bandwidth they provide. Pozar says that a third public access point is soon to be installed on Yerba Buena Island in the San Francisco Bay, which will link to the East Bay and light-up an underserved area called Treasure Island.

All of these access points are constructed with non-proprietary equipment and open protocols to keep costs down and to learn what technologies can be most easily adopted by lower income communities.

As evidence of the network's stability and flexibility, BARWN is working with the City of San Francisco to use this network for public safety communications—such as earthquake or disaster response. Pozar says one application for the unlicensed service would be to provide streaming video of a disaster site to command centers to evaluate response tactics.

Unlicensed Broadband is Not Just for Yuppies Anymore
It's an Appropriate Technology for Underserved Urban Areas

While policy makers in the U.S. debate over how to bridge the last mile, unlicensed technology is giving disadvantage communities the ability to confront and solve access issues for themselves. One shining example is the case of the EastServe network in East Manchester, England, where community members have installed a wireless broadband network connecting 350 households, 17 area schools, and nine community technology centers.

The EastServe network was created by residents from the towns of Beswick, Clayton and Openshaw through the British government's "Wired Up Communities" initiative, which pulls public and private entities to bring broadband Internet to disadvantaged areas. There are seven pilot communities across England in the Wired Up Communities initiative -- each of which is using a slightly different technology or implementation model to learn the best strategy to reach the UK last mile. EastServe is the flagship project for unlicensed wireless broadband, and a showcase for unlicensed wireless in urban areas.

For East Manchester, wireless was the only viable solution. Ninety percent of the population have no high-speed cable access, and 25% have no fixed-line phone service since many households only use mobile phones. With 80% of the population living in houses, almost half of which are publicly funded, the expense of laying cable or a DSL loop to each residence is especially prohibitive. But a wireless solution, with its flexible and facile installation, allows community stakeholders to set-up, manage and trouble-shoot technical problems themselves.

A local company, Gaia Technologies, has trained resident volunteers to install and maintain the 10 community access points currently in place. Volunteers from the neighborhoods will add an additional 15 access points in the next phases of the project. Over 700 households within a 6-mile area have signed up for the service, and project leaders estimate that with the ease of rooftop installation they can bring 100 new users per week onto the network.

Gaia Technologies Managing Director, Anas Mawla says the network is a ring formation of six backbone towers, which are located among the 17 schools and nine on-line centers on the network. These six towers provide a total of 26Mbits of data transmitted in narrow beam, point-to-point connections at 45 Mbps on the 5.8 GHz band. The backbone relies on a partial mesh design for redundancy. Proxim makes the 5.8 GHz transceivers.

Within this ring of towers, twenty-five 802.11b access points transmit in wedge-shaped sectors to reach households with up to 11 Mbps of data to be shared among users. EastServe uses Cisco Systems' Aironet customer premise antennas for the last-mile link to houses. Flat dwellers share a wireless link that connects directly to the backbone, demonstrating the network's scalability.

Since activating the network, the local telephone carrier has launched limited ADSL access to parts of East Manchester, however this service offers a much slower, asymmetrical service at higher prices than the EastServe wireless network. EastServe users also have access to a community Intranet; customer service provided by community members; and the ability to purchase new or recycled computers through the program. They also have the added comfort that they will soon own and maintain their network – no-longer at the mercy of a third-party provider to bring them the service.

WiFi Calling: Campuses Turn to WiFi for Voice Applications
An Emerging Cost-Effective Solution for Local and Wide Area Voice Service

Since the beginning of the wireless movement, college and corporate campuses have been fertile ground for extensive WiFi networks. The latest trend for campus organizations is to bypass local telephone carriers and use their unlicensed wireless networks to support voice applications.

In one example, the University of Arkansas invested $4 million in Cisco's call processing software, CallManager, to traffic local calls over the University's existing WiFi network. The University has reduced their monthly telephone service fees from $530,000 to $6,000 a month. At this savings rate, the University should recoup their call-processing investment in six months. Dartmouth College has a similar program, offering software to incoming freshman that turns wireless laptops and PDAs into "softphones."

Dartmouth implemented their voice over wireless local area network (VoWLAN) when they realized they were spending more money billing students for long-distance calls than they were taking in. The unlicensed VoWLAN provides a similar quality of service to traditional telephone service, but without the billing and administrative costs. H

ospitals have also been early adopters of VoWLAN technology. One company, Vocera has created an 802.11b communications device that doctors and nurses wear on their uniform collars to communicate with each other remotely. Users speak the name of the person they'd like to contact into the device, and they are instantly connected through the VoWLAN. The device has the potential to eliminate obtrusive use of intercoms and speakers that broadcast announcements or pages meant for only one person to an entire hospital floor.

Making the Last Mile First in Developing Economies
Unlicensed Networks Reaching the Poorest of the Poor

A general rule in introducing new technologies to developing economies is that one size does not fit all. Often, for a new technology to be economically viable in developing countries, substantial changes in the model must be made. One well-cited example of this is the case of bringing cellular phone service to rural Bangladesh. To address the lack of rural phone service, the Grameen Bank -- a micro-credit bank that makes small business loans to rural women -- started the Village Phone Program. In 1997 they began offering cellular phone loans to village "phone ladies" who then sold per-call phone

service to community members. The result is that there are now over 32,000 Grameen phones in rural Bangladesh and the model is being replicated in other developing economies.

Now that Wi-Fi is being scaled-up from hotspots to last-mile service in America, efforts have begun to make the wireless model work in developing economies. The Dandin Group, an unlicensed wireless engineering firm, has built successful networks on the island of Tonga and in the capital of Mongolia, Ulaan Bataar. China Unicom has begun fixed wireless deployments in the Guangzhou and Shenyang provinces, and China Netcom has built over 2,000 Wi-Fi hotspots in four of China's largest cities. But most deployments only reach relatively high-income users; and in that sense, the model is roughly the same as in more developed economies.

The biggest barrier to reaching the poorest of the poor is the high cost of equipment compared to the scant resources of individual users. Wireless Internet service providers need new ways to aggregate users and get the most out of each piece of technology. FirstMile Solutions, a consultancy of MIT Media Lab engineers, has taken a novel approach to this problem, effectually turning the mobility model on its head. Instead of building stationary transmitter towers to reach mobile users, as cellular phones work, FirstMile engineers in India have been experimenting with Mobile Access Points (MAPs) to bring high-speed connectivity to rural villages. By mounting wireless access points onto buses with daily routes to rural villages, one access point is able to serve many villages with periodic service.

The bus-mounted MAPs connect to Wi-Fi enabled computer centers located near the bus routes. Users are able to write email messages or record digital video messages, as in a typical Internet café. Then, when the bus drives by, the access point connects with the computer center and uploads all the stored files from the previous 24-hours, and delivers new messages to user in-boxes. When the bus drives back to its point of origin in a larger town, it connects with a fixed-base Internet connection and uploads all the data collected in its rounds, and downloads new data to be delivered the next day on its route.

The project is designed to fit the needs of rural villages lacking the resources or the demand for full-time connectivity. The periodic, "store-and-forward" connection creates a very specific communications application, a crucial component of new-technology adoption. And, like the Village Phone Program, users can purchase the service on an as needed basis.

In July, the World Radio Conference moved toward harmonized standards on the 5 GHz licensed-exempt band, making spectrum available at 5.15 – 5.25 GHz, 5.25 – 5.35 GHz, and 5.47 – 5.725 GHz frequencies. This move toward standardized unlicensed bands should provide equipment manufacturers with an incentive to reach global markets with an economy of scale for mass-produced transmitters and receivers. As unlicensed wireless equipment becomes more of a commodity, the developing world should benefit from more novel wireless applications.

Michigan Puts its Money in Unlicensed Spectrum
The first official loan of the Michigan Broadband Development Authority goes to local WISP

As state and local government policy makers look for solutions to their own last-mile issues, wireless broadband is getting more attention as a viable alternative to cable or DSL. The great test of wireless broadband as an accepted solution to the last-mile problem is the use of state funds to help build wireless networks. An example is the State of Michigan's Broadband Development Authority, which gave its vote of confidence to unlicensed wireless by awarding its inaugural loan to a local WISP. ISP Wireless was awarded a $350,000 loan in April 2003 to expand its service to seven cities in northern Michigan.

The Michigan Broadband Development Authority (MBDA) was created by the state legislature in 2002 to attract private sector investment in high-speed Internet deployment across the state. The MBDA offers low-cost loans to companies with proven business plans and a successful record of broadband deployments.

ISP Wireless, which has 200 wireless subscribers in addition to its established customer base of dial-up and DSL subscribers, is using the loan to purchase wireless transmitters and customer antennas to extend their network.

The WISP has selected the equipment manufacturer WaveRider's non-line-of-sight, 900 MHz point-to-multipoint transmitters and customer receivers for the last-mile connections. The company uses Trango Broadband's 5.8 GHz microwave transmitters for their point-to-point connections.

ISP Wireless President Chris Carey says the loan will establish seven new transmitter towers and bring 500 new subscribers online in the coming months. Carey says most of the point-to-point transmitters will be attached to grain elevators, which then connect to point-to-multipoint cell sectors in neighborhoods and communities.

Building the infrastructure to support the new network is much easier and less expensive than extending DSL loops or laying new cable lines. Depending on a customer's proximity and line-of-sight to the local access point, the WaveRider customer antennas can either be mounted on the customer's roof, or posted on the users' window sill or interior wall. The company is currently connecting between two and 10 new customers a day.

The unlicensed wireless service is less expensive and faster than DSL. ISP Wireless charges $49.95 per month for a symmetrical wireless connection of 384 Kbps, while a comparable DSL connection with same speed is $72.50 per month.

Carey says recent innovations in the unlicensed band technology have made a huge impact in his business. Before offering the wireless connection, dial-up and DSL installations were flat and it was becoming increasingly difficult to attract enterprise customers. However, since building the unlicensed network, the company's largest growth is in the small, medium and large enterprise market. ISP Wireless has connected

municipal offices for the City of Alma; a private K through12 school; an auto supply manufacturer and numerous small, and home-based businesses.

Attracting and building business growth is the goal of the Michigan Broadband Development Authority. According to a recent report by TechNet, a bipartisan organization of company CEO's, the state of Michigan is the national leader in promoting broadband deployment; and unlicensed spectrum is playing an increasing role in energizing business investment and bridging Michigan's last mile.

A Rural Municipal Network Expands
Leveraging a Municipal Unlicensed Network to Bridge the Residential Last-Mile

In 1996, four frustrated network administrators from the Allegheny County government abandoned their hopes that Verizon would build a high-speed telecom network for their community, and decided to leverage their municipal resources to build their own wireless municipal network. The result is Allconet (http://www.allconet.org) one of the nations most successful, wide area rural networks and a valuable model of local government collaboration and economic vision.

Network administrators representing the Allegheny County Government, the Board of Education, the Public Library System and the City of Cumberland initiated the project. Using initial funding from the Appalachian Regional Commission, the group built the first links of what has since grown to be a dual ring, 525-mile wireless SONET (Synchronous Optical Network). The initial phase of the network connected 90 municipal buildings including 27 schools, 6 libraries and dozens of county and non-profit organizations, and cost the county only $320,000--a fraction of what it would cost to build a wired network for the county.

The Allconet project has evolved in two phases: Allconet 1 focused on building a municipal wireless network and providing last-mile access to the county government and non-profit partners. State and federal grants have funded most of the $2.7 million costs for Allconet 1, with the local government providing $200,000. In the second phase of the project, Allconet 2, the county has enhanced the capacity of the network to support large enterprise applications. This summer the county will open the network to local ISPs to provide wireless access to an estimated 85% of the areas households, and 90% of local businesses. The county estimates that phase two of the project will cost roughly $2 million dollars, with $600,000 in county funds currently available and additional funds expected from the Universal Service Fund's E-Rate program.

The Allconet wireless SONET relies on eight radio transmitters perched on mountain vistas and foothills flanking the county. Instead of purchasing tower space, the transmitters are placed on two water tanks, the roof of the Fort Hill High School, a local bell tower, and three freestanding airport towers. The SONET ring architecture uses licensed frequencies on the 11, 18, and 23 GHz bands for backhaul transmissions, and the unlicensed bands (900 MHz and 2.4, 5.2 - 5.3 and 5.7 - 5.8 GHz) for last-mile connections to municipal and non-profit subscribers.

The Allconet SONET provides bandwidth capacity of 622 Mbps, which is greater than 12 DS3 lines. The SONET connects to the Internet using DS3 lines leased by the County Board Of Education and T1 lines provided by the State of Maryland's SAILOR network, which provides high-speed access to state libraries, and from nearby Frostburg State University.

Allconet 2 residential and business subscribers will all be connected with unlicensed last-mile connections. The engineering plans call for a scalable, redundant network weaved together with 32, 802.11b (Wi-Fi) access points; 48 access points for advanced service connections on the 5.7 GHz band; and 16 lower-frequency (900 MHz) transmitters for last-mile access to users who may not have perfect line-of-site to the towers. Because the project is being launched in phases, the county may have the option of using the first generation, non-line of site, Wi-MAX standard transmitters which are expected to be available from multiple vendors this year.

While the system is designed to support the future broadband access needs of the county's 72,000 residents, the County's goal is to leverage the network to attract federal government and private sector jobs. Already the network can support the private branch exchange (PBX) networks required for large call-centers or back-office operations that many large companies like to outsource to lower wage areas.

Allegheny County leaders are hoping that this advanced municipal network will have the capacity and reach to alter the economic landscape for the entire region. Other rural areas are watching closely, and similar projects – such as western North Carolina's Mountain Area Information Network (MAIN) and central Pennsylvania's Broadband Rural Access Information Network (BRAIN) – have also had strong starts to connect remote areas long-ignored by traditional broadband providers.